

1520 SWEPT FREQUENCY GENERATOR
SG-1020/UR
OPERATION

KAY ELEMETRICS CORP

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1520 SWEPT FREQUENCY GENERATOR

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KAY ELEMETRICS CORP

PINE BROOK, N.J.
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KAY ELEMETRICS CORP

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1520 SWEPT FREQUENCY GENERATOR

OPERATOR'S MANUAL

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GENERAL INFORMATION

1.1 INTRODUCTION

The Model 1520 is a wideband, solid state, sweep generator with a frequency coverage of 50 KHz to 1200 MHz in six overlapping bands. The unit delivers a full 0.5 V rms signal into 50 Ω from 50 KHz to 300 MHz and 1.0 V rms from 275 to 1200 MHz. The 1520 will provide accurate wide or narrow sweeps at center frequencies, determined by the operator, throughout the specified frequency range.

A general purpose lab type instrument, the Model 1520 is used for alignment, test, or calibration applications.

1.2 SPECIFICATIONS

1.2.1 FREQUENCY RANGE: 50 KHz to 1200 MHz in 6 switchable bands.

1.2.2 RF OUTPUT: 0.5 V rms into 50 Ω , 50 KHz to 300 MHz;
1.0 V rms into 50 Ω , 275 MHz to 1200 MHz.

1.2.3 OUTPUT FLATNESS: ± 0.5 db, 50 KHz to 800 MHz; ± 1.0 db, 800 MHz to 1200 MHz.
(maximum sweep width)

1.2.4 OUTPUT IMPEDANCE: 50 Ω .

1.2.5 FREQUENCY DRIFT: at 25 $^{\circ}$ $\pm 2^{\circ}$ C per ten minute interval after 30 minute warm up

on each band: .05-10 MHz Band ± 10 KHz or $\pm 0.3\%$, whichever is greater
1-300 MHz Band ± 50 KHz or $\pm 0.3\%$, whichever is greater
255-1200 MHz Bands $\pm 0.3\%$

1.2.6 SWEEP WIDTH: 50 KHz to 300 MHz; 10 KHz minimum to 300 MHz maximum.
(variable) 275 MHz to 1200 MHz; 100 KHz minimum to $> \pm 20\%$ of center.

1.2.7 FREQUENCY LINEARITY: 5% of full sweep.

1.2.8 SPURIOUS OUTPUT: > 20 db below fundamental output.

1.2.9 HARMONIC DISTORTION: > 30 db below fundamental output.

- 1.2.10 RF ATTENUATION: 0 to 70 db in 10 db steps; 0 to 10 db vernier.
- 1.2.11 ATTENUATION ACCURACY: ± 1 db.
- 1.2.12 SWEEP RATE: 0.5 to 6 Hz, variable; 6 to 60 Hz, variable; Line Triggered; CW.
- 1.2.13 HORIZONTAL OUTPUT: 5 volts peak-to-peak sawtooth at the sweep repetition rate.
- 1.2.14 EXTERNAL MARKER INPUT: Provision for two, at any frequency from 100 KHz to 100 MHz. Input voltage - 20 mv minimum. Amplitude continuously variable via front panel control.
- 1.2.15 INTERNAL MARKERS: Harmonic birdies at 1, 10, and 100 MHz.
Variable birdies from 100 KHz to 100 MHz.
Marker Accuracy: .005% for Harmonic; .02% for Variable.
Marker Amplitude: approximately 0.1 V peak-to-peak.

- 1.2.16 BLANKING: Switchable, unit's vertical output returned to zero reference level.
- 1.2.17 ELECTRICAL REQUIREMENTS: 115 V $\pm 10\%$, 60 Hz, 65 W approximately.

1.3 INSTALLATION

1.3.1 UNPACKING

Upon receipt of the Model 1520, visually inspect it for any damage that may have occurred in shipment. Pay particular attention to the condition of the cabinet, switches, connectors, and dial faces.

1.3.2 INITIAL INSTALLATION

The unit may be installed in any environment that is reasonably free from extremes in temperature, humidity, or vibration. Adequate ventilation is provided by the cabinet, however it should not be obstructed. Rack mounted models also require an adequate amount of air flow to prevent overheating.

SECTION II

OPERATION

2.1 INTRODUCTION

The information contained in this section is intended to familiarize the operator with the various controls and their functions. A detailed operating procedure is included and provides the basic interconnections and control settings necessary to operate the equipment.

2.2 FUNCTION OF CONTROLS AND SWITCHES

CONTROL	POSITION	FUNCTION
BANDWIDTH VARIABLE	VARIABLE	Controls the amount of sweep frequency deviation.
WIDE/NARROW SWITCH	WIDE	The maximum sweep width is available.
CALIBRATE	NARROW	The maximum sweep width available is approximately 1% of the wide sweep.
	VARIABLE	Provides a means of accurately calibrating the CENTER FREQUENCY dial to a specific frequency (optimum accuracy insured only when the screw-driver slot is in the vertical position).
CENTER FREQUENCY (Ten Turn Pot)	VARIABLE	Used to set the CENTER FREQUENCY as read on the dial.
COUNTER SWITCH	ON/OFF	In the OFF position, the counter circuits are disabled, reducing the amount of display flicker.
COUNTER DISPLAY	3 POSITION SWITCH	Indicates whether the counter is reading in KHz or MHz. Resolution is decreased as switch is rotated clockwise. See Figure 2.1.
DC BALANCE	VARIABLE	Adjusts for a minimum DC level shift in VERT output when the VERTICAL GAIN control is varied across its range. Usually only necessary to adjust when changing RF detectors.

CONTROL	POSITION	FUNCTION
FREQUENCY BAND	6 POSITION SWITCH	Selects any one of six frequency bands. Band in use is indicated by a light on the CENTER FREQUENCY dial.
HARMONIC MARKERS	4 POSITION SWITCH	Selects either the 1, 10, or 100 MHz harmonic birdie markers. An OFF position is provided.
MARKER SIZE	HARMONIC EXTERNAL VARIABLE	These three controls are used to determine the marker amplitude of the corresponding marker type.
NARROW BAND CENTER-ING	VARIABLE	This control is activated by placing the SWEEP WIDTH switch in NARROW. It is used to locate the exact center frequency (set under wide band conditions).
POWER SWITCH	ON	AC power is applied to all circuits of the Model 1520.
	OFF	The Model 1520 is completely de-energized.
RF ATTENUATION SWITCH	VARIABLE	Selects fixed amounts of attenuation from 0 to 70 db in 10db steps.
RF LEVEL	VARIABLE	Adjusts the level of the RF output over a 10 db range.
SWEEP RATE	SWITCH	Selects any one of the following sweep functions: 0.5 to 6 Hz, 6 to 60 Hz, Line Triggered, or CW.
	VARIABLE	Provides adjustment of the variable repetition rates over the range set by the selector switch (0.5 to 6, 6 to 60).
VARIABLE MARKER POSITION		Determines the horizontal position of the variable marker between 0.05 and 100 MHz. The FINE and COARSE controls provide precise settings of frequency (as read on the counter) or position.

CONTROL	POSITION	FUNCTION
VERTICAL BLANKING	ON/OFF	When in the ON position, the VERTICAL OUT channel is blanked during sweep retrace time resulting in a zero signal output reference. The RF is not internally blanked.
VERTICAL GAIN	VARIABLE	Amplification of approximately 0 to 32 db of gain is provided for the VERT INPUT signal. This permits low level signals to amplified before being displayed on the scope.

TABLE 2.1 COUNTER RESOLUTION

		RESOLUTION	
	GATE TIME	.05-10MHz BAND	1-300MHz BAND*
MHz (Fully CW)	1 ms	1 KHz	10 KHz
MHz (Middle)	10 ms	100 Hz	1 KHz
KHz (Fully CCW)	100 ms	10 Hz	100 Hz

*Counter operates at 100MHz and below only.

2.3 FUNCTION OF CONNECTORS

CONNECTOR	FUNCTION
EXTERNAL MARKERS	These two jacks provide a means of applying a CW signal to the Model 1520 to form center frequency and side band markers in the frequency range of 100 KHz to 100 MHz. The input signal should be 20 mv or greater. Signals can be applied at greater than 100 MHz if desired.
HORIZ OUT	Provides a means of coupling the horizontal sweep drive voltage to the oscilloscope.
RF DETECTOR	This connector is part of the plug-in detector and provides a 50 Ω input impedance for the RF signal.
RF OUT	Provides a means of coupling out the leveled, RF signal.
VERTICAL INPUT	When utilizing an external detector, this jack provides a means of coupling detected signals into the vertical channel.
VERTICAL OUT	Provides a means of coupling the vertical channel to the vertical input of the oscilloscope. The vertical signal contains the marker information plus the frequency response of the unit under test.

2.4 OPERATION

NOTE: The equipment is operable immediately after the power is turned on and the accuracy and stability are acceptable. To insure optimum specified accuracy, allow a one half hour warm up period. The center frequency is affected the same way when switching from band to band.

2.4.1 Interconnect the equipment as shown in Figure 1.

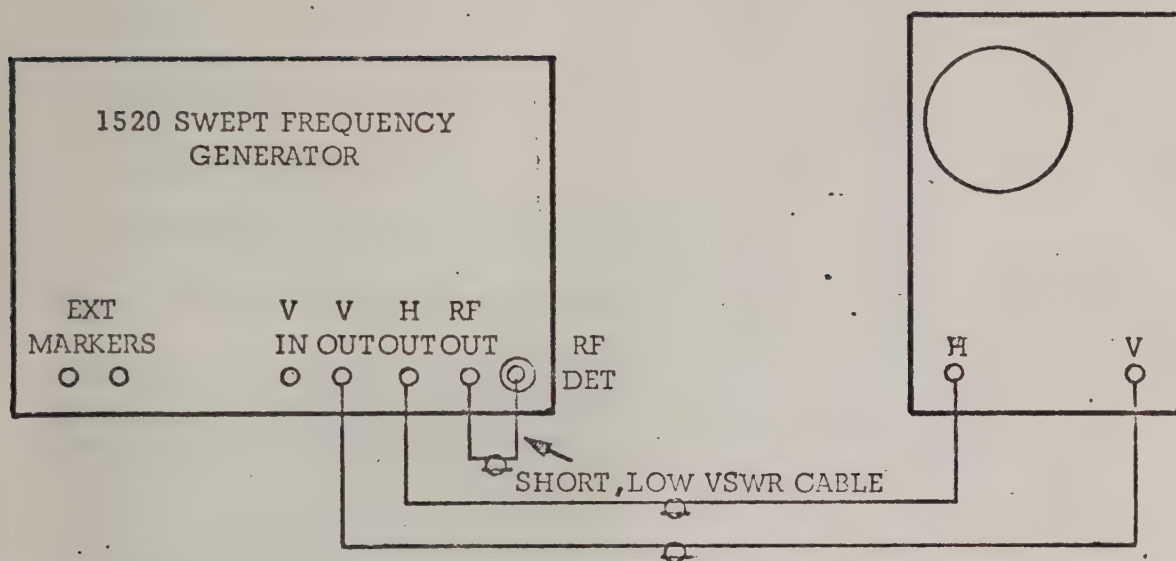


FIGURE 2.1 GENERAL TEST SET-UP

2.4.2 Set the oscilloscope controls as follows:

2.4.2.1 VERT GAIN: 0.5 volts/cm.

2.4.2.2 HORIZ GAIN: Adjust so that a 10 volt p/p input signal gives 10 cm of horizontal deflection.

2.4.3 Set the Model 1520 front panel controls as follows:

2.4.3.1 FREQUENCY BAND switch: desired band.

2.4.3.2 CENTER FREQUENCY control: center of selected band.

2.4.3.3 RF LEVEL: fully clockwise.

2.4.3.4 RF ATTENUATION: as required.

2.4.3.5 BAND WIDTH: WIDE, variable control fully clockwise.

2.4.3.6 NARROW BAND CENTERING: not operable.

2.4.3.7 SWEEP RATE: 6 to 60 Hz position, variable fully clockwise.

2.4.3.8 VERTICAL GAIN: mid-range.

2.4.3.9 DC BALANCE: set at factory to match RF detector; or mid-range.

2.4.3.10 VERTICAL BLANKING: ON.

2.4.3.11 COUNTER ON/OFF: OFF.

2.4.3.12 HARMONIC MARKER: OFF.

2.4.3.13 MARKER SIZE: All three controls fully CCW.

2.4.4 With the controls set as above, the indicated frequency band will be swept with the center as indicated on the CENTER FREQUENCY dial. A frequency response curve should be observed if the VERTICAL GAIN control is properly adjusted.

2.4.5 The desired frequency band is selected as follows:

2.4.5.1 Place the FREQUENCY BAND selector in the desired range.

2.4.5.2 Allow the unit to stabilize.

2.4.5.3 The selected band will be indicated by a light in the CENTER FREQUENCY dial.

2.4.6 CENTER FREQUENCY selection:

2.4.6.1 The frequency may be read directly from the dial.

2.4.6.2 Below 100 MHz, higher center frequency accuracy is obtained by using the variable marker to indicate the center frequency.

2.4.6.3 The calibration of the CENTER FREQUENCY dial for greater accuracy or narrow band operation is as follows:

2.4.6.3.1 Determine the dynamic center frequency of the swept RF by centering an EXTERNAL or harmonic marker on the scope trace while reducing the bandwidth (use the VARIABLE BANDWIDTH control) to a minimum.

2.4.6.3.2 Adjust the bandwidth controls for maximum bandwidth.

2.4.6.3.3 Adjust the horizontal controls of the oscilloscope so as to place the marker exactly at the center of the display. (The scope is now calibrated to read center frequency at any bandwidth.)

2.4.6.3.4 Calibration of the dial is accomplished as follows:

- (a) For EXTERNAL or HARMONIC markers: Select a marker frequency and set the CENTER FREQUENCY dial for the same frequency. Adjust the CALIBRATE control to place the marker exactly at the center of the sweep.
- (b) For the VARIABLE marker: Place the marker at the center of the sweep, the CENTER FREQUENCY dial at the desired frequency, and adjust the CALIBRATE control until the counter reads the desired frequency.

NOTE: Best accuracy for the above procedure is obtained when operating at reduced sweep widths. For best overall dial accuracy, the CALIBRATE control slot should always be returned to the vertical position. With the control in any other position the specified accuracy may be affected.

TABLE 2.2 CENTER FREQUENCY ACCURACIES

FREQUENCY BAND	DIAL*		FREQUENCY ACCURACY Using Counter as center Frequency Indicator
.05-10MHz	$\pm 100\text{KHz}$		$\pm .02\%$
1 - 300 MHz	1-100MHz	100-300MHz	1-100MHz 100-300MHz
	$\pm 3 \text{ MHz}$	$\pm 2 \%$	$\pm .02\%$
255-510MHz	$\pm 2\%$		
340-680MHz	$\pm 2\%$		
450-900MHz	$\pm 2\%$		
600-1200MHz	$\pm 2\%$		

*NOTE: Dial accuracy within specifications when CALIBRATE control slot is lined up with VERTICAL calibration marks.

2.4.7 SWEPT RF LEVEL adjustment:

2.4.7.1 The output level may be adjusted by varying the RF level through its range (0-10db).

2.4.7.2 The RF attenuator provides fixed 10 db steps of attenuation up to a total of 70 db.

2.4.8 SELECTION of BANDWIDTH:

2.4.8.1 Set the BANDWIDTH selector to WIDE and adjust the VARIABLE control for the desired width. Any one of the three marker systems can be used to establish an exact width.

2.4.8.2 For bandwidths of 1% or less, smaller amounts of residual FM and drift will be encountered if the narrow function is used as follows:

2.4.8.2.1 Establish an acceptable sweep under wide band conditions.

2.4.8.2.2 Center the response on the oscilloscope.

2.4.8.2.3 Select the NARROW sweep function.

2.4.8.2.4 Rotate the NARROW BAND CENTERING control in the direction of the indicator light that is extinguished until the crossover point between the two lights bein ON is reached. At the crossover point, and depending on the center frequency, bandwidth, and sweep rate, the lights will either be both ON or both OFF or will alternate being OFF and ON. In the last two cases, the operator should tune for equal brightness between the two lights.

2.4.8.2.5 The desired bandwidth may be set by adjusting the VARIABLE BANDWIDTH control while using any of the three marker systems to indicate the frequency.

2.4.8.3 Establish a narrow bandwidth sweep at a known center frequency.

2.4.8.3.1 For frequencies from 50 KHz to 100 MHz, proceed as follows:

(a) Place the VARIABLE MARKER in the center of the swept display.

(b) Turn the VARIABLE BANDWIDTH control fully counterclockwise.

- (c) Adjust the NARROW SWEEP CENTERING control for the desired center frequency reading on the counter. (See section on VARIABLE MARKER operation.)
- (d) OPTIONAL METHOD: Adjust the center frequency control for the crossover point of the indicator lights (see section 2.4.8.2.4). The CENTER FREQUENCY dial may now be used for noting the initial center frequency and is also set up to provide the same center frequency for wide sweeps.
- (e) Adjust the VARIABLE BANDWIDTH control for the desired bandwidth. The use of any of the three marker types is useful for insuring accuracy.

2.4.8.3.2 For frequencies above 100 MHz proceed as follows:

- (a) Set the CENTER FREQUENCY dial for any desired center frequency and proceed with steps 2.4.8.2.4 and 2.4.8.2.5.

2.4.9 SWEEP RATE ADJUSTMENT

2.4.9.1 The variable ranges (0.5 to 6 Hz and 6 to 60 Hz) are normally selected for the fastest rate that produces the least distortion of the response curve. The faster rates will produce the least flicker. At any given sweep rate, the amount of distortion depends on the response time of the unit under test and the detector; some high Q circuits will ring if swept too fast.

2.4.9.2 When operating at very narrow bandwidths, residual FM picked up by the system may become noticeable as a back and forth bobble of the signal. To reduce this FM bobble, proceed as follows:

- (a) Switch to NARROW BANDWIDTH (set up as for section 2.4.8.2.4).
- (b) If the bobble is still objectionable, switch to the LINE TRIGGERED range. All line frequency related FM will disappear.

NOTE: With the COUNTER ON/OFF switch in the ON position, residual FM will remain to the right of the variable marker (no counting error will be noted). The COUNTER switch should, therefore be OFF except when actually counting.

If the LINE TRIGGERED function should produce distortion, it is advisable to operate in one of the variable ranges which produces the minimum distortion.

2.4.10 DC BALANCE ADJUSTMENT

- 2.4.10.1 Turn the three MARKER SIZE controls fully counterclockwise.
- 2.4.10.2 Disconnect the RF signal from the detector while maintaining the connection between the detector and the Model 1520 (detector plugged into the 1520 or connected to the VERTICAL INPUT jack).
- 2.4.10.3 Set the oscilloscope's vertical gain to 10 mv/div and center the zero input reference level on the trace.
- 2.4.10.4 Vary the VERTICAL GAIN control through its entire range and see that the trace does not deflect vertically.
- 2.4.10.5 Eliminate any deflection of the trace by adjusting the DC BALANCE control.
- 2.4.10.6 Repeat this procedure any time the detector is changed.

2.4.11 VERTICAL GAIN ADJUSTMENT

- 2.4.11.1 Set the oscilloscope's vertical gain for 0.5 V/cm.
- 2.4.11.2 Adjust the VERTICAL GAIN control for a convenient amplitude. Very low level signals may make it necessary to increase the vertical sensitivity of the scope.
- 2.4.11.3 Adjust the MARKER SIZE controls as necessary.

2.4.12 VERTICAL BLANKING:

2.4.12.1 To establish a no-signal reference line place the VERTICAL BLANKING switch in the ON position. This blanks the signal at the VERTICAL OUT jack to zero.

2.4.12.2 With the VERTICAL BLANKING switch in the OFF position, both the forward and reverse sweeps are displayed on the scope.

2.4.13 VARIABLE MARKER OPERATION (.05 - 100 MHz)

NOTE: The accuracy of the variable marker is $\pm .02\%$ for swept frequency bandwidths of 8% or less of marker frequency. (An 8% bandwidth is approximately the maximum bandwidth at which $\pm .02\%$ can be discerned on a 10 cm scope display; $\pm .25$ mm or $.01''$. A 2% bandwidth is more useable). At bandwidths above 8% of the marker frequency, the variable marker accuracy is $\pm 0.25\%$ of bandwidth.

2.4.13.1 Set the COUNTER DISPLAY switch to the desired counter resolution. Resolution obtained is indicated by the decimal point on the display or may be determined from the chart in the section concerning the function of controls and switches.

NOTE: Setting a resolution greater than the specified accuracy of the reading is not recommended. Reduced flicker when counting is insured by working at the minimum useful frequency resolution.

2.4.13.2 Turn the COUNTER ON/OFF switch to ON and read the frequency directly from the counter. The marker being counted is indicated by a bright dot at the peak.

2.4.13.3 Adjust the VARIABLE MARKER POSITION controls to place the marker at its desired point or frequency.

2.4.13.4 Adjust the MARKER SIZE - VARIABLE control for a convenient marker amplitude.

2.4.13.5 Read the marker frequency directly from the counter.

2.4.13.6 If counting produces objectionable flicker, turn the counter OFF when it is not necessary to count the frequency.

2.4.13.7 When the SWEEP RATE, BANDWIDTH, or COUNTER DISPLAY controls are varied, the counter frequency may vary slightly. This variation will be within specifications. Counter variation is minimized by setting the resolution of the counter within its specified limits.

2.4.14 HARMONIC MARKER OPERATION

2.4.14.1 Select any one of the harmonic marker frequencies (1, 10, and 100 MHz) by means of the HARMONIC MARKER switch.

2.4.14.2 Vary the MARKER SIZE - HARMONIC control until the desired amplitude is obtained.

2.4.15. EXTERNAL MARKER OPERATION:

NOTE: External markers may be generated at any point in the frequency range although they are only specified from 100 KHz to 100 MHz.

2.4.15.1 To generate a center frequency marker, connect an external signal generator to the EXTERNAL MARKER input jack.

2.4.15.2 Select the desired frequency from this signal generator and adjust its RF level for some value less than 0.5 V rms.

- 2.4.15.3 Adjust the MARKER SIZE - EXTERNAL control for a useable marker.
- 2.4.15.4 To minimize harmonics, keep the RF input level as low as possible and the setting of the MARKER SIZE control as high as possible without introducing excess noise into the scope display.
- 2.4.15.5 A sideband marker can be generated by feeding a signal into the remaining marker input at the proper frequency.
- 2.4.15.6 The marker level may be adjusted by regulating the relative signal level of the two generators.

SECTION III
CHECK-OUT PROCEDURE

3.1 INTRODUCTION

The information contained in this section can enable the operator of the 1520 Sweep Frequency Generator to perform a general, overall check of his instrument. If desired, these check-outs can be applied whenever:

1. The unit is initially received.
2. The unit undergoes preventative maintenance.
3. Any components have been replaced.

For actual alignment procedure and troubleshooting information, reference should be made to the Maintenance Manual.

3.2 PROCEDURE

3.2.1 TEST EQUIPMENT REQUIREMENTS:

NOTE: It is suggested that the test equipment listing be closely adhered to and that any necessary substitution meet or exceed the accuracy specifications of substituted unit.

<u>ITEM</u>	<u>MINIMUM PERFORMANCE SPECIFICATIONS</u>	<u>IDENTIFICATION</u>
Power Meter	Power Range: 0.1 to 10Mw Instrumentation Accuracy: +1% Frequency Capability: 10-1200 MHz	Hewlett-Packard 432A 431C.

ITEM	MINIMUM PERFORMANCE SPECIFICATIONS	IDENTIFICATION
Thermistor Mount	VSWR: 1.75 Max 10-30 MHz 1.35 Max 30-100 MHz Limit of Error: $\pm$ 4% of affixed value Type: Temperature compensated Frequency range: 10 to 1200 MHz	Hewlett-Packard 8478B
RF Voltmeter	VSWR: 1.3 Max (50 ohm) Frequency Range: .05 to 50 MHz Limit of Error: $\pm$ 3%	Hewlett-Packard 411-A
Oscilloscope	Range: DC-300 KHz Sensitivity: 10 Mv Horizontal external input linearity: Less or equal to 2%	Tektronix 547 or Tektronix 545 with Type 1A1 preamplifier.
Signal Generators	Range: 1-300 MHz Accuracy: $\pm$ 1% Output: 0.02 to 0.1 VRMS	Hewlett-Packard H 19-606B 50 KHz-65 MHz And H03-608E (10-480 MHz)
	Range: 255-1200 MHz Accuracy: $\pm$ 1% Output: 0.02 to 0.1 VRMS	Hewlett-Packard Ho3-608E (10-480 MHz) and 612A (480- 1230 MHz)
Bridge, Standing Wave Radio	Range 3-1200 MHz VSWR Error: $\pm$ 3%	Anzac RB-3 (Mod.)
Counter, Frequency	Range: .05 to 1200MHz Accuracy: $\pm$ 0.001% (10 PPM)	Hewlett-Packard 5245L with the 5253B and 5254C Converter.

<u>ITEM</u>	<u>MINIMUM PERFORMANCE SPECIFICATIONS</u>	<u>IDENTIFICATION</u>
Spectrum Analyzer	Frequency Response: <u>+2db</u> Range: .05-3600MHz	Hewlett-Packard 8553B/8552B in 141S Display section (1KHz-110MHz) 8551B/851B (10MHz-40GHz)
Attenuator, Variable	Range: .05-1200MHz Accuracy: <u>+0.3db</u> Attenuation: 1 db Switchable Flatness: <u>+0.2db</u> -any octave	Kay Elemetrics Corp. 461A Type 110-0

3.2.2 INITIAL CONDITIONS

3.2.2.1 Factory Ambient Condition (Room Temperature)

3.2.2.2 Power: 115V, 60 cps, AC

3.2.2.3 Warm up: 30 minutes.

3.2.3 FREQUENCY ACCURACY, AND LINEARITY

3.2.3.1 DIAL FREQUENCY ACCURACY

A. Test Conditions

- (1) 1/2 hour warm-up for each frequency band.
- (2) Bandwidth selector WIDE.
- (3) Calibrate Control - screwdriver slot set to vertical position.
- (4) RF Level Control set to MAXIMUM.
- (5) RF attenuation switch set to 10 db.
- (6) Harmonic marker selector switch set to 10 MHz position (1 MHz for .05-10 MHz band and the 1-10 MHz region of the 1 - 300 MHz band.)
- (7) Sweep Rate Control - 6 - 60 Hz. VARIABLE to MAXIMUM.
- (8) Vertical Blanking control to ON.
- (9) Establish a swept display on oscilloscope, as per Figure 3.1, of 5 to 6 CM amplitude.

B. Test Procedure

- (1) Adjust bandwidth displayed on oscilloscope to 6 harmonic markers with 2 CM spacing between markers. 10 CM between markers on .05-10 MHz band.
- (2) Introduce external known signal to external marker input to verify frequency.
- (3) Adjust harmonic marker size to approximately three CM and external marker to approximately five CM peak-to-peak.
- (4) Turn dial and bandwidth to frequency and band to be measured taking care to eliminate parallax error.
- (5) Read the subdivisions between the oscilloscope center and the harmonic marker. They represent the residual dial errors. Convert to frequency.

3.2.3.2 LINEARITY

A. Initial Conditions

- (1) Variable Bandwidth control set fully clockwise.
- (2) Bandwidth selector to WIDE.
- (3) RF Level control set to MAX.
- (4) RF attenuator switch set to 10 db.
- (5) Sweep Rate switch to 6 - 60 Hz, VARIABLE fully clockwise.
- (6) Counter switch to OFF.
- (7) Vertical Blanking switch to ON.
- (8) Marker Size controls - EXTERNAL & VARIABLE completely CCW.
- (9) Set up the equipment as shown in Figure 3.1.
- (10) Adjust the VERTICAL GAIN control for about 4 CM response amplitude on the scope screen.

B. Test Procedure

- (1) Turn on the appropriate Harmonic Markers as shown in Table 3.1.
- (2) Adjust the Variable Bandwidth control so that the RF is swept between the markers indicated in Table 3.2.
- (3) Adjust the Variable Bandwidth and Center Frequency controls so as to place the sweep limit markers exactly on the scope extreme left and right hand graticules, see Figure 3.2.
- (4) The mid frequency marker should now fall within 0.5 CM (5%) of the center graticule.
- (5) Check linearity at frequencies indicated in Table 3.2.

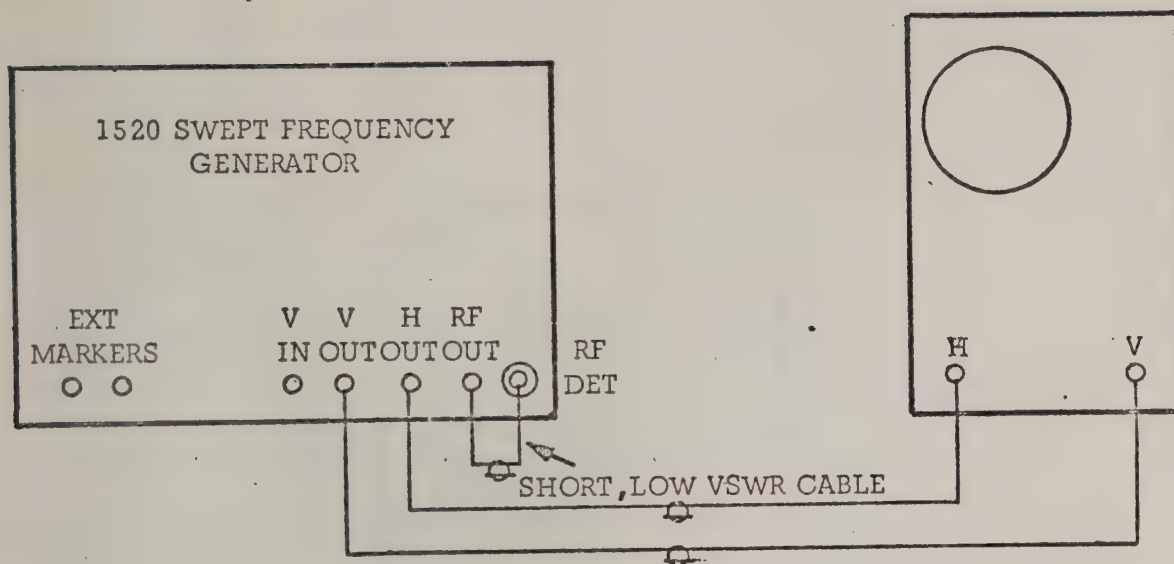


FIGURE 3.1 LINEARITY TEST SET-UP

TABLE 3.1 HARMONIC MARKER USED FOR LINEARITY CHECKS

BAND (MHz)	HARMONIC MARKER (MHz)
.05-10	1 MHz
1-300	10 MHz
255-510	
340-680	
450-900	10 MHz
600-1200	100 MHz

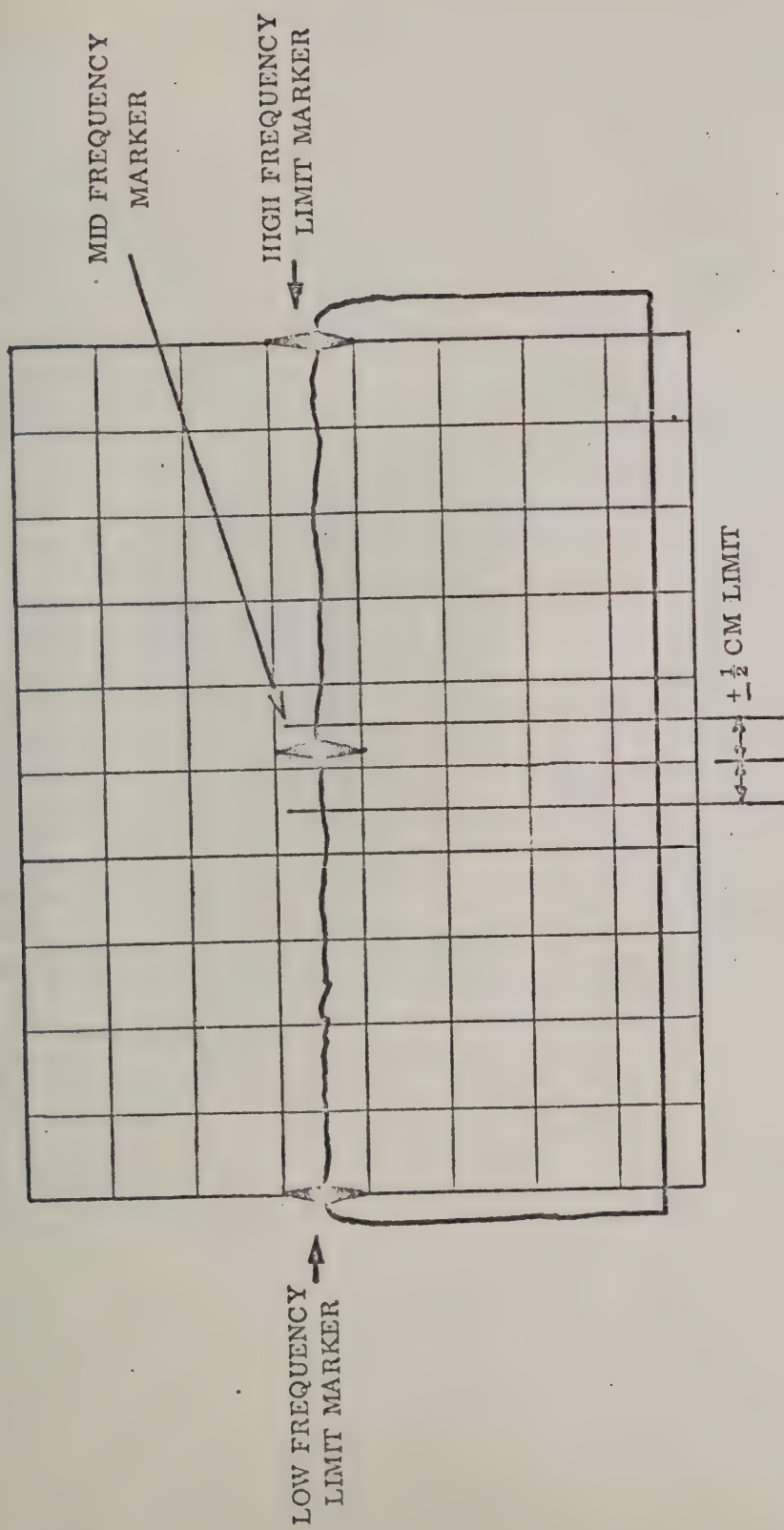


FIGURE 3.2 LINEARITY DISPLAY

TABLE 3.2

<u>BAND</u>	<u>CENTER FREQUENCY (MHZ)</u>	<u>SWEEP RANGE</u>
.05-10 MHz	1	'zero beat' & 2 MHz
.05-10 MHz	5	4 and 6 MHz
.05-10 MHz	9	8 & 10 MHz
1-300 MHz	30	'zero beat' & 60 MHz
1-300 MHz	150	120 & 180 MHz
1-300 MHz	270	240 & 300 MHz
255-510 MHz	280	260 & 300 MHz
255-510 MHz	380	360 & 400 MHz
255-510 MHz	490	470 & 510 MHz
340-680 MHz	370	340 & 400 MHz
340-680 MHz	510	480 & 540 MHz
340-680 MHz	650	620 & 680 MHz
450-900 MHz	490	450 & 530 MHz
450-900 MHz	680	640 & 720 MHz
450-900 MHz	860	820 & 900 MHz
600-1200 MHz	700	600 & 800 MHz
600-1200 MHz	900	800 & 1000 MHz
600-1200 MHz	1100	1000 & 1200 MHz

3.2.4 OUTPUT VOLTAGE AND OUTPUT VOLTAGE VARIATION

3.2.4.1 TEST CONDITIONS

- (1) Bandwidth selector - WIDE.
- (2) RF Level control to MAX.
- (3) RF Attenuation switch set to 0 db.
- (4) Sweep Rate switch to CW.

3.2.4.2 TEST PROCEDURE

- (1) Set the Frequency Band selector and the Center Frequency control so as to obtain the frequency to be measured at the RF OUT jack.
- (2) At the RF OUT jack measure the RMS RF voltage and see that it falls within the limits of the specifications at the frequencies given in Table 3.3.
- (3) For frequencies below 10 MHz use an accurate RMS RF voltmeter; at 10 MHz and above use a power meter.

3.2.5 ATTENUATOR ACCURACY

3.2.5.1 TEST CONDITIONS

- (1) Bandwidth selector WIDE.
- (2) RF Level control - MAX.
- (3) Sweep Rate selector to CW.

3.2.5.2 TEST PROCEDURE

The attenuator can be checked within the unit by the substitution method. The substituted attenuators must provide ± 0.2 db or better accuracy over the frequency range from .05 to 1200 MHz. A spectrum analyzer or any sensitive RF detector having a sensitivity of -70 DBM or better may be used. Proceed as follows:

- (1) Set RF Attenuator to 10 db and adjust spectrum analyzer for a measureable response.
- (2) Set RF Attenuator to 0 db and substitute the external 10 db standard attenuator. Read the change in level from Step (1). The level should be within ± 1 db of Step (1).
- (3) Repeat steps 1 and 2 for attenuator values of 20, 30, 40, 50, 60, and 70 db.
- (4) The 1520A should be checked at the following frequencies: 10, 300, 510, 680, 900, and 1200 MHz.

TABLE 3.3

OUTPUT VOLTAGE & OUTPUT VOLTAGE VARIATION				
BAND (MHz)	FREQUENCY (MHz)	SPECIFICATIONS		
		NOMINAL VOLTAGE (VRMS) •	LIMITS ABOUT NOMINAL VOLTAGE (DB)	
			LOW	HIGH
.05-10	.05	0.5	-0.5	+0.5
	10			
1-300	1	0.5		
	300			
255-510	255	1		
	510			
340-680	340			
	680			
450-900	450		-0.5	+0.5
	900		-0.75	+0.75
600-1200	600	1	-0.5	+0.5
	1200		-0.75	+0.75

3.2.6 - SPURIOUS AND HARMONIC DISTORTION

3.2.6.1 TEST CONDITIONS

- (1) Bandwidth selector - WIDE.
- (2) RF Level control - MAX.
- (3) Sweep Rate selector - CW.
- (4) RF Attenuator - 10 db.

3.2.6.2 TEST PROCEDURE

- (1) Connect a spectrum analyzer that covers the frequency range of .05 to 3600 MHz to the RF OUT connectors.
- (2) At the frequency being tested, scan the entire spectrum of .05 to 3600 MHz looking for harmonics and spurious responses. Harmonics and spurious are to be down equal to or greater than 30 and 20 db respectively.
- (3) Be sure to identify all responses less than 30 db below the fundamental so spectrum analyzer generated images and spurious are not confused with the 1520 output.
- (4) Check for harmonics and spurious at the fundamental frequencies given in Table 3.4.

3.2.7 SWEEP REPETITION FREQUENCY

- 3.2.7.1 Connect the HORIZ OUT jack to the vertical input of the scope.
- 3.2.7.2 Set the Sweep Rate to 6-60 Hz range.
- 3.2.7.3 Using the scope as a reference, and by adjusting the Variable control, see that the sweep rate varies between 6 and 60 Hz or greater.
- 3.2.7.4 Check the 0.5 - 6 Hz range as above.
- 3.2.7.5 Set the scope to line synchronization and see that the Line Triggered range is synchronized to the line frequency (no drift on the scope) at a 60 Hz rate.

3.2.8 HORIZONTAL DEFLECTION VOLTAGE

With the 1520 connected as in Section 3.2.7, check the amplitude of the sweep voltage and see that it is greater than 5 V peak-to-peak on the 0.5-6, 6-60, and Line Triggered ranges.

TABLE 3.4

SPURIOUS & HARMONIC DISTORTION

BAND	FREQUENCY	SPURIOUS OUTPUTS (DB BELOW FUNDAMENTAL)	HARMONIC (DB BELOW FUNDAMENTAL)
(MHZ)	(MHz)	SPECIFIED	SPECIFIED
.05-10	.05	≥ 20 DB	≥ 30 DB
	10		
1-300	1		
	300		
255-510	255		
	510		
340-680	340		
	680		
450-900	450		
	900		
600-1200	600		
	1200	≥ 20 DB	≥ 30 DB

TABLE 3.5

CRYSTAL HARMONIC MARKER SPECIFICATIONS			
FREQUENCY (FUNDAMENTAL OSCILLATOR) (MHz)	ACCURACY (MHz) LIMITS ($\pm$.005% - 50 PPM)		
	LOW	HIGH	SPEC
1	0.999950	1.000050	0.1
10	9.999500	10.000500	"
100	99.995000	100.005000	"

TABLE 3.6

VARIABLE MARKER SPECIFICATIONS					
BAND (MHz)	FREQUENCY (MHz)	COUNTER DISPLAY SWITCH	ACCURACY (MHz) LIMITS ($\pm$.02%)		
			LOW	HIGH	SPEC
.05-10	1	KHz	0.999800	1.000200	0.1 V
	10	CENTER MHz	9.998000	10.002000	"
1-300	50	CENTER MHz	49.990000	50.010000	"
	100	CENTER MHz	99.980000	100.020000	"

3.2.9 DETECTOR OPERATION

3.2.9.1 FLATNESS

A. Test Conditions

- (1) Bandwidth selector - WIDE.
- (2) Variable Bandwidth - fully clockwise.
- (3) RF Level control - MAX.
- (4) Center Frequency control - 5 MHz (will now be centered for all bands).
- (5) Sweep Rate selector to 0.5 - 6 Hz, Variable - completely clockwise.
- (6) RF Attenuator - 10 db.
- (7) Vertical Blanking - ON.
- (8) Scope vertical channel to 0.1 v/cm sensitivity.

B. Test Procedure

- (1) Connect the equipment as shown in Figure 3.3.
- (2) Use an attenuator which has ± 0.2 db flatness, or better, in any of the six bands.
- (3) For optimum results it is best to connect the attenuator directly to the RF OUT jack of 1520 at one end and directly to the detector at the other end.
- (4) Starting with the 600 MHz to 1200 MHz band, sweep the entire frequency range using markers to ascertain that the frequency response measured is within the band limits.
- (5) Adjust the Vertical Gain control for a reasonable scope presentation.
- (6) Switch in 1 db of attenuation in the added attenuator and note the change in level corresponding to the 1 db change. Check to see if the unattenuated variations are within the 1 db limit (± 0.5 db).
- (7) Repeat this procedure on all other bands.
- (8) On the .05 - 10 MHz band, the bandwidth should be reduced when checking the detector in the .05 MHz to 1 MHz region. Also the Low Frequency Detector Adaptor should be used below 1 MHz. The Variable Marker may be used for frequency identification.

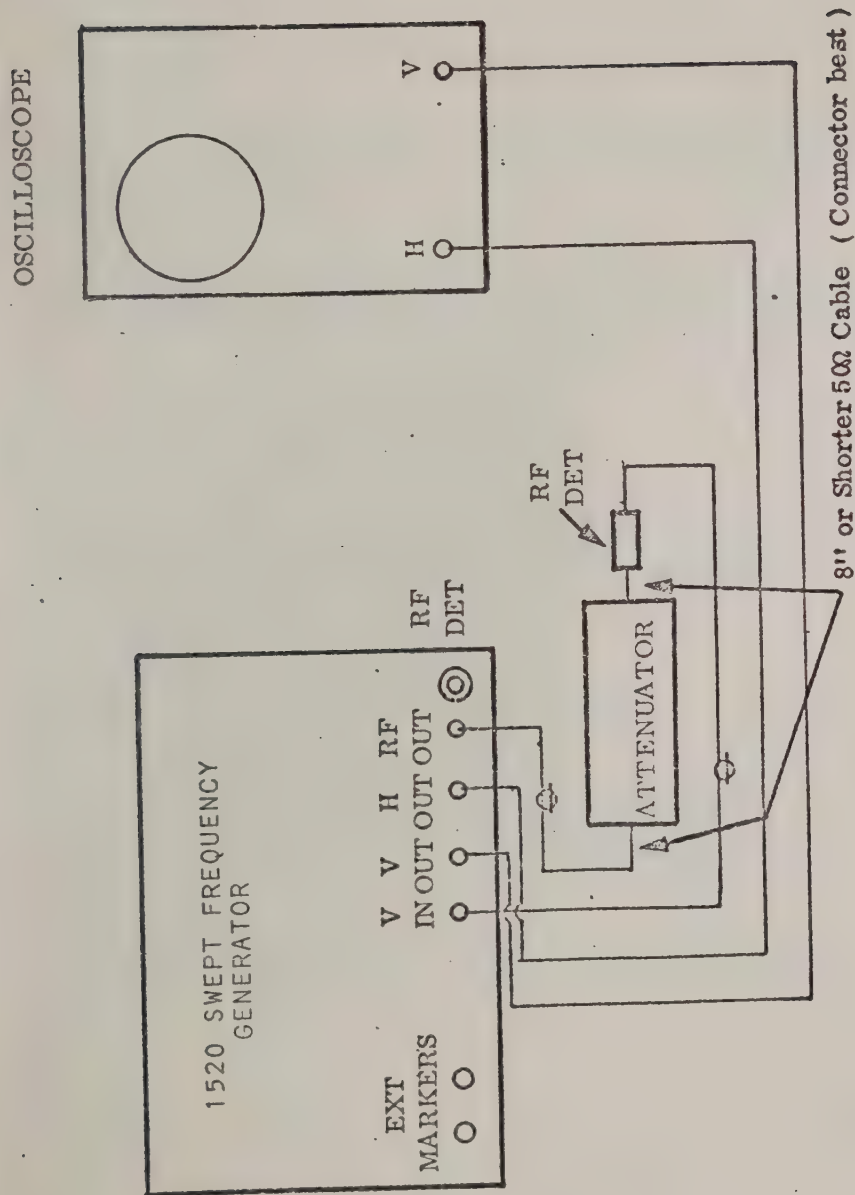


FIGURE 3.3 DETECTOR TEST SET-UP

3.2.9.2 VSWR

A. Initial Conditions

- (1) Same as 3.2.9.1 (Flatness).
- (2) Use a VSWR bridge at the RF OUT jack of the 1520. Refer to manufacturer's manual for this test procedure.

B. Test Procedure

Sweep all six bands and see that the detector VSWR is less than or equal to 1.3:1 for .05 - 900 MHz and 1.4:1 for 900 - 100 MHz ranges.

3.2.10 MARKER INPUT OPERATION

3.2.10.1 INITIAL CONDITIONS

Same as section 3.2.9A except Sweep Rate to be 6 - 60 Hz range, and bandwidth to be set to 100 MHz in 1 - 300 MHz range.

3.2.10.2 TEST PROCEDURE

- (1) Connect the equipment as in Figure 3.1.
- (2) Connect a 20 mv level signal to the EXT MARKERS input jack, at the frequency to be measured.
- (3) Adjust the External Marker Size control and see that a marker of at least .03 volts peak-to-peak is obtained.
- (4) Check at 0.1 and 10 MHz on the .05 - 10 MHz band and at 1 and 100 MHz on the 1 - 300 MHz band.
- (5) It will be necessary to reduce the Bandwidth so the .05 and 1 MHz marker may be seen properly. The low frequency detector adaptor (981A) should be used for this check.

3.2.11 INTERNAL MARKER CAPABILITY

3.2.11.1 CRYSTAL HARMONIC MARKERS

A. Accuracy

- (1) Remove top cover of the instrument.
- (2) Locate the unused BNC connector (TP1) on the harmonic marker module in the center of the instrument.
- (3) Connect a cable between the connector (TP1) and a frequency counter capable of reading 1, 10, and 100 MHz to $\pm .001\%$ (10 PPM) accuracy.
- (4) Turn the Harmonic Marker switch to 1 MHz and read the frequency on the counter. The marker accuracy should be $\pm .005\%$ or better. Refer to Table 3.5 for specifications.
- (5) Repeat for the 10 and 100 MHz markers.

B. Minimum Amplitude

(1) Initial Conditions

- a. Bandwidth selector - WIDE.
- b. Variable Bandwidth fully clockwise (initial).
- c. RF Level control - MAX.
- d. RF Attenuator - 10 db.
- e. Vertical Blanking - ON.
- f. Sweep Rate selector - 6 - 60 Hz Variable fully clockwise.
- g. Counter - OFF.
- h. Harmonic Markers - OFF.
- i. Harmonic Marker Size - completely CCW.
- j. Scope Vertical Channel - 0.1 v/cm sensitivity.

(2) Test Procedure

- a. Turn on the 1 MHz Harmonic Markers.
- b. Adjust Harmonic Marker Size for a 0.1 volt peak-to-peak or more marker.
- c. Adjust Bandwidth control for approximately one CM between markers.
- d. Turn Center Frequency control (if necessary) so that the marker height over the whole band is checked. (A 0.1 V pp marker should be obtainable.)
- e. Check all six bands.
- f. Repeat for 10 and 100 MHz markers on all applicable bands. (100 MHz markers are to be checked at full bandwidth.)

3.2.11.2 VARIABLE MARKER

A. Initial Conditions

- (1) Bandwidth selector - NARROW.
- (2) Sweep Rate selector - CW.
- (3) RF Level control - MAX.
- (4) RF Attenuator - 0 db.
- (5) Counter - ON.
- (6) Connect frequency Counter capable of reading from .05 to 100 MHz with $\pm .005\%$ accuracy to the RF OUT jack. .
- (7) Terminate 50 Ω RF cable at counter input with 50 Ω if the counter input is a high impedance.

B. Test Procedure

- (1) Switch to the .05 - 10 MHz band and compare the frequency on the Variable Marker counter with that read on the external frequency counter.
- (2) Check the Variable Marker counter at 1 and 10 MHz by adjusting the Narrow Sweep Centering control.
- (3) Repeat for the 1 - 300 MHz band and check at 50 and 100 MHz.
- (4) The limits and Counter Display switch settings are given in Table 3.6.
- (5) Set Sweep Rate selector to 6 - 60 Hz range.
- (6) Set up equipment as in Figure 1.
- (7) Set scope to 0.1 v/cm sensitivity.
- (8) Set counter display to right hand MHz position.
- (9) Adjust the Variable Marker Position and Variable Marker Size controls for a marker and see that a marker of greater amplitude than 0.1 V is obtained.
- (10) Check both the 0.5 - 10 MHz and the 1-300 MHz bands.



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